

Chapter 14

Beyond Pen and Paper: Reimagining Assessment of Personal Relationships and Quality of Life Using Digital Technologies



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Introduction

Maintaining personal relationships represents an integral part of one's self-care and thus contributes significantly to one's overall health. According to self-determination theory, relatedness is one of the three basic psychological needs humans possess [1]. Maintaining constructive and healthy personal relationships is a way of satisfying this core psychological need. Continuously neglecting one's personal relationships and relatedness with others can potentially cause various psychopathological symptoms and prove detrimental to overall health. This chapter will focus on personal relationships in the context of quality of life (QoL) and new digital technologies, highlighting the potential benefits of implementing these technologies in research on these issues as well as limitations that may slow their widespread adoption.

The World Health Organization (WHO) defines personal relationship quality as "the extent to which people feel the companionship, love, and support they desire from the intimate relationships in their life" [2]. Personal relationships can be further described as a network that is created through the close connections one maintains with others and that implies an emotional investment of some sort [3]. Personal relationships are also highly mutable and are impacted daily by one's immediate social environment [4]. While the perceived quality of one's relationships influences QoL to a significant degree, it is also important to note that the quality of one's social interactions (and not the quantity) is the best predictor of self-reported health [5], like the relationships themselves, the perceived quality of relationships is also susceptible to change. While the perceived quality of one's relationships influences

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QoL to a significant degree and is dependent upon numerous factors. Social exchange theory, for example, argues that the perceived quality of any relationship depends on the (1) the perceived benefit vs. cost ratio (BCR); (2) the individual's comparison level (CL), or what they believe they deserve to get out of a particular relationship in terms of BCR; and lastly, (3) the individual's comparison level for alternative (CL_{alt}), which is the lowest BCR outcome they are willing to accept in a specific relationship given the perceived BCR outcomes of alternative relationships or of merely being alone [6]. Furthermore, equity theory suggests that BCR outcomes determine the quality of a personal relationship to the extent that they affect the relationship's perceived fairness [7].

Research on QoL and personal relationships, along with other complex social science issues, has until now been burdened and held back by technological limitations. Researchers of these topics, for instance, have generally accepted a reliance on self-reported data from small sample sizes. Additionally, due to ethical and financial limitations, collection techniques such as mobility traces and the use of personal call records have been relatively rare. Such limitations have had particularly adverse implications for intricate longitudinal research designs, making it difficult for researchers to engage individual participants over time. The number of iterations or data points researchers have been able to study has also been limited, as methodologies based on pen-and-paper self-reporting were costly and made the logging of daily, weekly, or even monthly changes in behaviors and states procedurally burdensome.

However, with the advent of computers, the Internet, and, most importantly, the nearly universal adoption of smartphones, a more suitable way to record such data emerged. Unlike traditional survey instruments, modern devices such as smartphones, smartwatches, and other wearables allow researchers to monitor behaviors and social interactions effortlessly and without additional engagement from participants. They have also allowed further innovations in the measurement of personal relationships by enabling real-time and synchronous data recording. Moreover, developments in modern data science, including advancements in sensor networks, machine learning, deep learning, and AI, offer novel ways of capturing and analyzing observed phenomena. In accordance with General Data Protection Regulation (GDPR) guidelines, researchers can accumulate large amounts of private data, such as location information, call logs, and messages (from SMS and applications such as Facebook Messenger, WhatsApp, and Viber), provided they first obtain participants' permission, which has permitted novel insights into a range of scientific inquiries. Cloud technologies, in turn, allow for almost unlimited data storage, which removes the limitations on sample size that troubled previous research. Finally, the global availability of smartphones allows sample representativeness in relevant populations to be more easily attained, thereby ensuring studies' external validity. Some pioneering researchers have already applied algorithms to data pertaining to mobile phone usage in order to measure different facets of communication, such as the frequency and duration of virtual communications and their relationship to tie strength [8].

Given these developments, this chapter aims, first, to explore the methodologies that have been used until now in studies focusing on the assessment of QoL and personal relationships, indicating, where relevant, their deficiencies and shortcomings; and, second, to propose a methodology that overcomes these shortcomings by using new digital technologies to capture and analyze relevant data in a reliable and timely manner.

Assessment of Personal Relationships and Their Impact on QoL

In studying personal relationships and their relation to QoL, researchers have relied on a variety of existing validated QoL measures that include assessments of the quantity, quality, and intensity of personal relationships to quantify QoL. As a variable, personal relationships can encompass a diverse range of phenomena, potentially including everything from marital relationship, kinship, and friendship to neighborhood-based relationships and acquaintances with fellow members of a church or club. Some studies, for instance, have considered the concept of relationship to equally imply both sexual and private relations, hence overlapping personal relationships with relationships of sexual intimacy (as covered in the WHOQOL facet “Sexual Activity” [2]). In some studies, personal relationship measures have overlapped with measures from the WHOQOL “Social Support” facet, which focuses more on the social structures an individual belongs to and the social support that is available to them when needed than personal relationships in general [2].

Below we provide a list of psychometrically standardized and validated QoL measures that involve some assessment of personal relationships as a variable. Taken together, these measures (a) apply to a range of demographics, including ages ranging from childhood to adulthood; (b) take various operationalizations of personal relationships into account, ranging from holistic to multi-faceted approaches, and (c) address various socio-environmental contexts, ranging from a particular context to a collective context, such as family.

1. WHOQOL-100 [9].

The World Health Organization has made sure to develop and to publish an instrument that measures quality of life in a quantitative manner. It consists of 100 items and therefore is titled WHOQOL-100. This instrument produces various scores, namely related to (a) particular facets of quality of life (e.g., social support and financial resources); (b) larger domains (e.g., physical, psychological and social relationship domain), and (c) overall quality of life and general health. With regards to personal relationships, WHOQOL-100 contains items such as “How satisfied are you with your personal relationships?” Furthermore, WHOQOL-100 is both culturally sensitive and psychometrically sound.

2. **KIDSCREEN-27** [10–13].

The KIDSCREEN project involved 13 European countries in the development of a cross-culturally harmonized QoL measure designed to be administered to children. The resulting KIDSCREEN instrument was based on literature reviews, expert consultation, and focus groups conducted in all the participating countries. The pilot version consisted of 185 items, which, after elimination of some items, was reduced to 52 of the original items. Later, a shorter, 27-item version of the same measure, called “KIDSCREEN-27,” was created and validated [14]. Concerning personal relationships and their relation to QoL, KIDSCREEN-27 assesses the quality of personal relationships a child can develop in school. Items such as “Have you spent time with your friends?” “Have you had fun with your friends?” and “Have you and your friends helped each other?” are intended to evaluate the safety net of personal relationships that serve as building blocks in the development of one’s self-esteem.

3. **Satisfaction with Life Scale (SWLS)** [15].

A widely used and validated measure [16–18], the SWLS encompasses five broad, global items and allows respondents to weight domains of their lives according to their own beliefs and values. The five-item scale provides a holistic and overarching assessment of an individual’s satisfaction with their life. In the area of personal relationships, the SWLS’s measure of QoL takes into account items such as “In most ways, my life is close to my ideal,” “The conditions of my life are excellent,” and “I am satisfied with my life,” to which participants respond with a rating from 1 (strongly disagree) to 7 (strongly agree). Although the items do not reference personal relationships directly, individuals with close, fulfilling relationships are much more likely to report being satisfied with their lives or describing the conditions of their life as excellent or ideal. Assessments of the quality of one’s relationships can therefore be a useful predictor of an individual’s ratings for these three items.

4. **RAND-36** [19–21].

This measure has been validated in multiple studies [22, 23] and represents one of the most common measures of health-related QoL (HRQoL). It generates ordinal level data for each of its 36 items, which are in turn aggregated to sub-scale scores [22]. When assessing the quality of life with regards to personal relationships, RAND-36 limits the time frame of the retrospection. This can be shown in the following item: “During the past 4 weeks, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors or groups.” The participants are then required to choose between responses varying from “all of the time” to “none of the time.”

5. **Beach Center Family Quality of Life (FQOL) Scale** [24–26].

The FQOL scale is an inventory consisting of 25 items rated on a five-point Likert-type scale that has been widely used and validated. It measures satisfaction with family life as a significant factor in QoL. In particular, it assesses family interaction, parenting, emotional well-being, physical/material well-being, and disability-related support [24] and contains items such as “My family members talk openly with each other,” “My family is able to handle life’s ups and downs,” and “My family enjoys spending time together.”

Apart from these validated measures, some researchers have leveraged non-standardized instruments and interviews to assess QoL, while others have applied more innovative approaches, such as extrapolating QoL measures from tests of social cognition and self-reported measures of social understanding [27]. However, as these approaches are far from widely adopted and often do not consider social relationships, we do not elaborate on these in this chapter.

Assessment of Personal Relationships Via Digital Item Representation

Having discussed the most common approaches to assessing personal relationships in measures of QoL, we now outline ways in which the items included in these measures have been assessed using digital technologies. We define digital item representation as the digitalization of any item of a particular instrument that maintains the format in which the item was traditionally recorded (such as binary or Likert scale formats). For an item assessing how much time an individual spent with their spouse in the past week, for example, this might involve the collection and recording of relevant information via GPS, Cell-ID positioning, WiFi information, or Bluetooth signals acquired directly from both spouses' smartphones and identifying the intervals when the two devices were in close proximity, thus rendering the individual's self-reporting superfluous. The automation that such techniques may increase engagement among study participants and motivate them to provide more data while also reducing dropout rates. It could also be argued that the quantitative and objective data derived from GPS, Cell-ID, WiFi, and Bluetooth technologies is likely to be a more accurate source of information than participants' subjective recollections [28, 29]. Such a position is further supported by research that has demonstrated that the context, wording, and format of questions can significantly impact the responses one receives [30]. Leveraging quantitative and objective datasets in the manner described above allows one to avoid the introduction of error from these sources.

An example of how digital techniques can be used to investigate social relationships is provided in a study conducted by Wiese et al. [8], where the researchers used a computational model to assess and classify personal relationships. Using call and text message logs from smartphones as inputs, Wiese et al. leveraged an algorithm to classify participants' contacts into three relationship categories: family, work, and social relationships. Based on extracted features such as the intensity, regularity, duration, and medium of communication, the authors were able to classify relationship categories with up to 90.5% accuracy [8]. Meanwhile, an ambitious approach to relationship imaging is the social MRI method developed by Aharony et al. [31]. Using credit card records and information on social media and mobile phone use, including calls and text messaging, this method provides an objective means of visualizing social systems. The authors also utilized self-reporting to collect Big Five personality tests and assessments of participants'

momentary moods and sleep quality, which were later used to detect correlations between these variables and aspects of participants' social relationships. By incorporating vast amounts of privacy-sensitive data in their model's framework, the authors were able to "help further our understanding of the interconnections and mechanics of human society" [31].

From Paper-Based Surveys to Digital Item Representation

Every instrument mentioned in section "Assessment of Personal Relationships Via Digital Item Representation" operationalizes a specific variable or set of variables corresponding to a specific item in terms of data that can be collected from digital devices. Incorporating digital item representation is a process that involves replacing traditional data recording methods (in particular, the method of self-reporting) with more technologically savvy ones. An initial step towards digital item representation is made with the use of electronic patient-reported outcomes (ePRO; [32]), which adapts traditional, paper-based means of assessing patient states as patient-reported outcomes (PROs; [33]) to a digital format so that patients can complete them electronically. The next step in implementing digital item representation is to replace the self-reported data sources, which are memory-based, subjective, and infrequent, with quantitative context- and sensor-based sources that are objective and frequent. In what follows, we discuss the latter of these steps, focusing in particular on the ways digital item representation might be applied to the QoL measures described in section "Assessment of Personal Relationships and Their Impact on QoL" in order to better quantify the aspects of personal relationships that influence QoL.

To illustrate how digital item representation could be applied in the case of the WHOQOL facets, we take as an example a study by Chang et al. [34] that explored the mediating effect of depression on WHOQOL facets such as positive feeling and social support. In this study, depression was measured via traditional paper-based self-reporting. To assess each individual's depression and the quality of their personal relationships, the researchers used a WHOQOL-100 item "How alone do you feel in your life?" Another WHOQOL-100 item that would also be suitable for digital representation is "How satisfied are you with your personal relationships?"

In this case, the researchers, along with the healthcare practitioners caring for the patient, might have benefited from having additional, more objective data sources regarding the intensity and frequency of the patient's social interactions. It has been demonstrated, for instance, that depressive patients tend to suffer cognitive distortions that lead them to downplay positive events in their life, which further exacerbates feelings of depression [35, 36] and could lead to inaccurate self-reporting. As a step towards digital item representation, collecting GPS, Cell-ID, WiFi, and/or Bluetooth data from the patient would have allowed the researchers to objectively measure the time the patient spent at home or close to those whom they recognize

as their significant others. An individual's close friends and contacts could be recognized by training an algorithm to assess the intensity and frequency of communications with specific individuals as well as analyze the individual's social media profiles and use of social media platforms [37]. This approach could provide a reliable way of evaluating the quality of individuals' relationships that is more accurate than asking them directly, leading to more objective assessments of the WHOQOL-BREF facet relating to personal relationships, which asks "How satisfied are you with your personal relationships?". By improving the accuracy of information, it would also allow both practitioners and researchers to better distinguish causal patterns between aspects of personal relationships and QoL. Finally, in the case of depression, as studied by Chang et al., the use of these measurement techniques could significantly impact researchers' or practitioners' assessments regarding the state of an individual's depression, the cause of their depression, and the potential mediating impact of personal relationships on their depression.

The KIDSCREEN-27 measure, meanwhile, includes a facet called "Peers and Social Support" [38]. The traditional paper-based KIDSCREEN-27 tries to operationalize this facet via items such as "Have you and your friends helped each other?" [11]. However, a digital representation of this item would be possible via an algorithm that incorporates sociometric techniques to render a sociogram, which would in turn provide information about specific peer dynamics inside an observed cohort of children [39]. To develop a clear, unbiased picture of this item, this algorithm could monitor the social network activity of a child (including information such as GPS data) and analyze the online content they are posting, sharing, liking, or commenting on (e.g., on their phone, tablet, or computer), as well as other relevant information such as the number of hours the child spends playing outside or in multiplayer games online.

As for the Satisfaction with Life Scale (SWLS; [15]), traditional items that ask participants to retrospectively assess and self-report their satisfaction with their lives could easily be digitalized via a mobile application that would occasionally prompt the individual to engage in a brief QoL assessment on their phones. Such an assessment would leverage methods such as experience sampling methods (ESM; [40, 41]), also referred to as ecological momentary assessment (EMA; [42]), and be designed to capture momentary, self-reported ratings of experiences, moods, thoughts, symptoms, or behaviors that are expected to change over time. Such momentary methods have been shown to be psychometrically superior to the usual, retrospective self-reports with their longer recall periods [43]. The near-ubiquitous availability and affordability of smartphones has contributed significantly to the realization of the ESM/EMA methodology's true potential by facilitating the capture of momentary data. Not only do individuals in most developed countries already possess this potential research hardware [44], but they also carry it at their side throughout the day [45], providing researchers with a potentially unlimited stream of self-reported as well as passive datasets. Despite the benefits of conducting self-reporting with a smartphone, however, there is still room for improvement. In a comprehensive review of the use of mobile phone devices in ESM, Van Berkel et al. [46], have noted that the notifications prompting participants to rate their feelings

are often burdensome. These prompts can be adapted by analyzing user-generated data to send the prompts at times when the individual is not occupied with other tasks.

While self-reports provide important information on an individual's situational contexts, they continue to rely on the user and require mobile notifications that are likely to continue being somewhat disruptive. As described above, data concerning one's situational context can be collected passively by leveraging multiple sensors that are embedded within smartphones by default [47]. For example, an automatic, continuously sensing smartphone-based application may incorporate data from a phone's accelerometer, microphone, light sensor, GPS, Cell-ID, WiFi, and Bluetooth activity. Data collected through smartphone sensing—including call logs, messages, and data on sleep, physical activity, and location—could also provide information about individuals' social interactions, activities, and mobility [48]. It is further possible to create a computational model that leverages deep learning technologies for classification tasks on data received from sources such as GPS, Cell-ID, WLAN, and call, SMS and social media logs. In summary, the techniques of digital item representation discussed above, including the use of ESM/EMA-based self-reporting and the collection of passive datasets using smartphones, could be leveraged for SWLS assessments in individuals' daily lives. Using smartphones for momentary self-reporting can improve the reliability of individuals' responses to items such as "In most ways, my life is close to my ideal," "The conditions of my life are excellent," and "I am satisfied with my life." Meanwhile, computational models of individuals' social, physical, and recreational activity developed through passively collected data can help researchers and practitioners better assess the veracity of responses and the factors that are correlated with positive or negative assessments.

Another instrument mentioned above that is used for assessing personal relationships is the RAND-36 [22]. Apart from asking participants to report the same information via a digital platform and thus leveraging the ESM/EMA approach, there are specific methods that can be implemented to complement self-reported RAND-36 data. In section "Assessment of Personal Relationships and Their Impact on QoL" we have already emphasized a specific RAND-36 item pertaining to personal relationships ("During the past 4 weeks, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors or groups"). The scope of this item is fairly broad and we can therefore measure it in various ways. Firstly, it can be assessed through analysis of the specific patterns or content of one's conversations. Conversations can be logged to detect patterns, while text collected from messaging apps and SMS logs can be semantically analyzed. An example of how an algorithm can be deployed to analyze textual output on social media is found in the recent case of Weibo users being monitored amidst the COVID crisis in China. The algorithm identified persons at risk of suicide and alerted responsible volunteers to contact authorities [49]. Secondly, to assess the tangible element of RAND-36's social activities, an algorithm that analyzes textual output could be implemented in combination with GPS, Cell-ID, WiFi, and Bluetooth proximity data to complement self-reported responses.

Thirdly, the emotional element of social activities could be further evaluated based on analysis of the emotional content and intensity of virtual interactions found in messaging app and SMS logs, including the use of emoticons. Self-reporting concerning the facet of positive social interactions could be complemented with GPS, Cell-ID, WiFi, and Bluetooth data that indicates an individual's most frequently visited places (via geolocation) and time spent in proximity to other individuals (via analysis of other devices in one's proximity).

Finally, in the case of the Beach Center FQOL [25], which contains items such as "My family members talk openly with each other," "My family is able to handle life's ups and downs," and "My family enjoys spending time together," digital item representation could be carried out using GPS, Cell-ID, WiFi, and Bluetooth proximity data for the individual and their family members. Logging the locations where family members spend time together and the duration of their interactions could provide insight into familial social relationships and enrich the data gathered from self-reporting. Furthermore the call, SMS, and messaging app logs of family members might be compared to assess individual family members' communication styles. Multiple communication parameters could be recorded, such as frequency, duration, content, expression style (analyzed for emotional expressions), and most preferred recipient. If a family collectively uses a messaging app such as Viber or WhatsApp, a group chat would offer valuable data for assessing individual family members' communication styles while exploring family dynamics.

A summary of suggestions for implementing digital item representation in the QoL measures discussed above is presented in Table 14.1.

Researchers seeking to assess QoL using QoL measures such as those mentioned above can enrich their methodological toolboxes by making use of accurate, timely, and privacy-conscious computational models of personal relationships developed using the techniques mentioned above. Since many researchers continue to use self-report-based, non-standardized, single-item QoL measures that are conceptually broad and fail to establish structural relations between variables or provide in-depth insights (e.g., "Describe your quality of life"; [27, 50–52]), in the following section we discuss the necessity for further research to establish the validity of digital item representations.

Discussion: Limitations of Digital Item Representation

As discussed above, digital assessment via smartphones and wearables can provide researchers with larger sample sizes and render more accurate, synchronous measurements. Problems relating to sample size, representativeness, external validity, and assessment standardization could be singlehandedly solved by using validated digital platforms to mine and store data. An important issue that emerges as researchers move towards collecting data from applications and other smartphone metrics, however, is privacy. There is rising concern among mobile phone users regarding

Table 14.1 Proposed digital item representations of items from selected QoL questionnaires

Instrument	Items	Sources to quantify the factor
<u>WHOQOL-100</u>	“How alone do you feel in your life?”; “How satisfied are you with your personal relationships?”	Smartphone (GPS, Cell-ID, WLAN, data use info for indoor/outdoor activity assessment; call, SMS, social media messenger logs); ESM/EMA (for loneliness assessment)
<u>KIDSCREEN-27</u>	“Have you and your friends helped each other?”	Smartphone (calls, social media activity); gaming consoles (gameplay logs); personal computers (eLearning platforms, gameplay logs)
<u>SWLS</u>	“How would you rate your satisfaction with your own life in the past three months?”; “How often do you feel sad?”	Smartphone (call, SMS, social media messenger logs); ESM/EMA (for sadness assessment)
<u>RAND-36</u>	“During the past 4 weeks, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors or groups.”	Smartphone (GPS, Cell-ID, WLAN info; call, SMS, social media messenger logs); ESM/EMA (for quality of personal relationship rating assessment)
<u>Beach Center FQOL</u>	“My family enjoys spending time together”; “My family members talk openly with each other.”	Smartphone (GPS, Cell-ID, WLAN info; call, SMS, social media messenger logs for family members)

privacy, data sharing within applications, and security breaches [53–55], the latter of which allow unwanted parties to collect certain information about users and use it for marketing or more sinister purposes. For this reason, the European Union introduced the General Data Protection Regulation (GDPR) in 2018, which focuses on data protection and privacy limitations and outlines necessary data protection practices in the European Union. These regulations thus specify legal and ethical limitations to the data practices researchers in Europe can adopt to complement standard survey practices. As regulations in distinct areas are likely to differ, the ways in which digital research methodologies can be implemented will vary greatly by geographic region.

Furthermore, with the use of data-gathering applications and algorithms, elaborate consent forms and data security protocols need to be implemented to protect participants’ privacy. Rather than study the relevant regulations and implement these protocols, many researchers are likely to opt out of using such tools despite their benefits. However, initial steps have been made towards implementing these methods more broadly, while several studies have been able to evaluate users’ attitudes towards data sharing, providing future researchers with concise and specific suggestions concerning how to increase the validity and trustworthiness of their

digital instruments [56]. When collecting smartphone, wearable, or EMA data from users in order to assess their relationships, one essential requirement is that researchers be clear about the immediate aims of their research, as well as the fact that their ultimate goal is to improve the individual's life quality in the long term. As far as child privacy is concerned, when using instruments such as the KIDSCREEN-27, it is of the utmost importance that researchers acquire parental permission before collecting any data.

The scope of the research presented in this chapter has had certain limitations. We do not offer a systematic literature review of all the instruments used to evaluate personal relationships in relation to QoL, nor is our discussion of the possibilities offered by smartphones and wearables for the digital quantification of the above items comprehensive, as such devices as smartphone gyroscopes and wearable heart rate and galvanic skin response monitors likely present additional research applications. Nevertheless, this chapter has opened a discussion on the digitalization of current methods of assessing personal relationship as a factor in ratings of QoL.

Looking towards the future, recent research results have shown that the use of new, personal, miniaturized technologies is bound to become prevalent. Indeed, there are already individuals who are taking part in the “quantified self” movement, leveraging these technologies for assessment of their own personal relationships [57]. One noteworthy wearable device in this trend is the Filip Smartwatch (<https://www.myfilip.com/>), which supports family communication and location-based information exchange without the use of a smartphone. Developments in the quantified self community are at the forefront of the trend of “self-knowledge through numbers,” and personal relationships are just one of the relevant areas individuals seek to quantify and improve. Overall, technologies used to assess personal relationships are examples of quality of life technologies (QoLT), a term referring to any technologies used for assessing or improving an individual's QoL. These technologies leverage the increasing availability of miniaturized, communication sensor- and actuator-based, context-rich technologies for computation and storage that can be embedded within personal devices such as smartphones and wearables [58]. There is therefore a promising future in the use of QoLT for the assessment of personal relationships based on data collected from daily life environments.

Concluding Remarks

With the further implementation and standardization of digital item representations for the assessment of personal relationships and QoL, researchers and practitioners will have excellent opportunities develop more accurate and timely knowledge about their study participants and patients. As this chapter has discussed, smartphones and wearables can be utilized to perform standardized momentary QoL assessments, which can be administered to individuals through a simple and user-friendly mobile interface. At the same time, the fact that the methods described in

this chapter are unobtrusive provides researchers the opportunity to obtain a more nuanced longitudinal, context-based view of individuals' personal relationships and QoL and to identify behavioral correlations. Leveraging both self-assessments and passive datasets, relationship models could be developed that provide researchers with more information while measuring an individual's states and behaviors in real-time and in their present context, allowing for better assessment of questions such as "How alone do you feel in your life?" Finally, similar to the use of standardized tests, objectively acquired data would enable behavioral and computer scientists access to quantitative data that is standardized and comparable, permitting the development of algorithms that provide further insight into the connections between aspects of personal relationships and QoL. Implementing these technologies in new ways can thus lead to new improvements in individuals' everyday lives.

References

1. Deci EL, Ryan RM. Intrinsic motivation and self-determination in human behavior. New York: Plenum; 1985.
2. WHOQOL PROGRAMME. Measuring Quality of Life. The World Health Organization Quality of Life Instruments (The Whoqol-100 and The Whoqol-Bref); 1997. https://www.who.int/mental_health/media/en/68.pdf
3. Allen LF, Babin EA, McEwan B. Emotional investment: an exploration of young adult friends' emotional experience and expression using an investment model framework. *J Soc Pers Relat*. 2012;29(2):206–27.
4. Duck S, editor. Understanding relationship processes. Dynamics of relationships, vol. 4. Sage; 1994.
5. Fiorillo D, Sabatini F. Quality and quantity: the role of social interactions in self-reported individual health. *Soc Sci Med*. 2011;73(11):1644–52.
6. Redmond MV. Social exchange theory; 2015. English Technical Reports and White Papers.
7. Messick D, Cook K. Equity theory: psychological and sociological perspectives. Praeger; 1983.
8. Wiese J, Min J-K, Hong JI, Zimmerman J. You never call, you never write: call and SMS logs do not always indicate tie strength. In: Proceedings of the 18th ACM conference of computer supported cooperative work & social computing. ACM; 2015. p. 765–74.
9. Whoqol Group. Development of the World Health Organization WHOQOL-BREF quality of life assessment. *Psychol Med*. 1998;28(3):551–8.
10. Andersen JR, Natvig GK, Haraldstad K, et al. Psychometric properties of the Norwegian version of the Kidscreen-27 questionnaire. *Health Qual Life Outcomes*. 2016;14:58.
11. Berman AH, Liu B, Ullman S, Jadbäck I, Engström K. Children's quality of life based on the KIDSCREEN-27: child self-report, parent ratings and child-parent agreement in a Swedish random population sample. *PLoS One*. 2016;11(3):e0150545.
12. Power R, Akhter R, Muhit M, Wadud S, Heanoy E, Karim T, Badawi N, Khandaker G. Cross-cultural validation of the Bengali version KIDSCREEN-27 quality of life questionnaire. *BMC Pediatr*. 2019;19 <https://doi.org/10.1186/s12887-018-1373-7>.
13. Vélez CM, Lugo-Agudelo LH, Hernández-Herrera GN, García-García HI. Colombian Rasch validation of KIDSCREEN-27 quality of life questionnaire. *Health Qual Life Outcomes*. 2016;14:67.

14. Ravens-Sieberer. Screening for and promotion of children and adolescents health: A European Public Health Perspective (KIDSCREEN); 2008.
15. Diener ED, Emmons RA, Larsen RJ, Griffin S. The satisfaction with life scale. *J Pers Assess.* 1985;1985(49):71–5.
16. Galanakis M, Lakioti A, Pezirkianidis C, Karakasidou E, Stalikas A. Reliability and validity of the satisfaction with life scale (SWLS) in a Greek sample. *Int J Human Soc Stud.* 2017;5:120–7.
17. López-Ortega M, Torres-Castro S, Rosas-Carrasco O. Psychometric properties of the satisfaction with life scale (SWLS): secondary analysis of the Mexican health and aging study. *Health Qual Life Outcomes.* 2016;14:170.
18. Pavot W, Diener E, Colvin CR, Sandvik E. Further validation of the satisfaction with life scale: evidence for the cross-method convergence of well-being measures. *J Pers Assess.* 1991;57(1):149–61.
19. Hays RD, Morales LS. The RAND-36 measure of health-related quality of life. The Finnish Medical Society Duodecim; 2001.
20. Hays R, Sherbourne C, Mazel R. The Rand 36-item health survey 1.0. *Health Econ.* 1993;2:217–27.
21. Steward AL, Sherbourne C, Hayes RD, et al. Summary and discussion of MOS measures. In: Stewart AL, Ware JE, editors. *Measures functioning and well-being: the medical outcome study approach.* Durham: Duke University Press; 1992. p. 345–71.
22. Orwelius L, Nilsson M, Nilsson E, Wenemark M, Walfridsson U, Lundström M, Taft C, Palaszewski B, Kristenson M. The Swedish RAND-36 health survey – reliability and responsiveness assessed inpatient populations using Svensson’s method for paired ordinal data. *J Patient-Reported Outcomes.* 2017;2(1):4.
23. Vanderzee K, Sanderman R, Heyink J, de Haes H. Psychometric qualities of the RAND 36-item health survey 1.0: a multidimensional measure of general health status. *Int J Behav Med.* 1996;3:104–22.
24. Hoffman L, Marquis J, Poston D, Summers J, Turnbull A. Assessing family outcomes: psychometric evaluation of the beach center family quality of life scale. *J Marriage Fam.* 2006;68 <https://doi.org/10.1111/j.1741-3737.2006.00314.x>.
25. Poston D, Turnbull A, Park J, Mannan H, Marquis J, Wang M. Family quality of life: a qualitative inquiry. *Ment Retard.* 2003;41(5):313–28.
26. Summers JA, Poston DJ, Turnbull AP, et al. Conceptualizing and measuring family quality of life. *J Intellect Disabil Res.* 2005;49(Pt 10):777–83.
27. Szemere E, Jokeit H. Quality of life is social – towards an improvement of social abilities in patients with epilepsy. *Seizure.* 2015;26:12–21.
28. Tsiouri C, Wac K. Towards smartphone-based assessment of burnout. In: *International conference on mobile computing, applications, and services.* Springer; 2013. p. 158–65.
29. Insel TR. Digital phenotyping: technology for a new Science of behavior. *JAMA.* 2017;318(13):1215–6.
30. Schwarz N. Self-reports: how the questions shape the answers. *Am Psychol.* 1999;54(2):93.
31. Aharony N, Pan W, Ip C, Khayal I, Pentland A. Social fMRI: investigating and shaping social mechanisms in the real world. *Pervasive Mobile Comput.* 2011;7(6):643–59.
32. Coons SJ, Eremenco S, Lundy JJ, O’Donohoe P, O’Gorman H, Malizia W. Capturing patient-reported outcome (PRO) data electronically: the past, present, and promise of ePRO measurement in clinical trials. *Patient.* 2015;8(4):301–9. <https://doi.org/10.1007/s40271-014-0090-z>.
33. Mayo NE, Figueiredo S, Ahmed S, Bartlett SJ. Montréal accord on patient-reported outcomes (PROs) use series—paper 2: terminology proposed to measure what matters in health. *J Clin Epidemiol.* 2017;89:119–24.

34. Chang YC, Yao G, Hu SC, Wang JD. Depression affects the scores of all facets of the WHOQOL-BREF and may mediate the effects of physical disability among community-dwelling older adults. *PLoS One*. 2015;10(5):e0128356.
35. Beck AT. Cognitive therapy and the emotional disorders. International Universities Press. 1976.
36. Beck AT, Rush AJ, Shaw BF, Emery G. Cognitive Therapy of Depression. New York: Guilford Press. 1979.
37. Krakan S, Humski L, Skočir Z. Determination of friendship intensity between online social network users based on their interaction. *Vjesn. / Tech. Gaz.* [Internet]. 2018;25:655–62.
38. Wehmeier PM, Schacht A, Barkley RA. Social and emotional impairment in children and adolescents with ADHD and the impact on quality of life. *J Adolesc Health*. 2010;46(3):209–17.
39. Kulawiak PR, Wilbert J. Introduction of a new method for representing the sociometric status within the peer group: the example of sociometrically neglected children. *Int J Res Method Educ*. 2020;43(2):127–45.
40. Hektner JM, Schmidt JA, Csikszentmihalyi M. Experience sampling method: measuring the quality of everyday life. Sage; 2007.
41. Larson R, Csikszentmihalyi M. The experience sampling method. In: *Flow and the foundations of positive psychology*. Dordrecht: Springer; 2014. p. 21–34.
42. Shiffman S, Stone AA, Hufford MR. Ecological momentary assessment. *Annu Rev Clin Psychol*. 2008;4:1–32. <https://doi.org/10.1146/annurev.clinpsy.3.022806.091415>. PMID: 18509902.
43. Ebner-Priemer UW, Trull TJ. Ecological momentary assessment of mood disorders and mood dysregulation. *Psychol Assess*. 2009;21(4):463.
44. Pew Research Center. 2021. Mobile fact sheet. [Report]. <https://www.pewresearch.org/internet/fact-sheet/mobile/>
45. Dey AK, Wac K, Ferreira D, Tassini K, Hong JH, Ramos J. Getting closer: an empirical investigation of the proximity of user to their smart phones. In: *Proceedings of the 13th international conference on Ubiquitous computing*; 2011. p. 163–72.
46. Van Berkel N, Ferreira D, Kostakov V. The experience sampling method on mobile devices. *ACM Comput Surveys (CSUR)*. 2017;50(6):1–40.
47. Gouveia R, Karapanos E. Footprint Tracker: Supporting Diary studies with lifelogging. In *CHI 2013: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. 2013; pp. 2921–30. <https://doi.org/10.1145/2470654.2481405>.
48. Harari GM, Lane ND, Wang R, Crosier BS, Campbell AT, Gosling SD. Using smartphones to collect behavioral data in psychological science: opportunities, practical considerations, and challenges. *Perspect Psychol Sci*. 2016;11(6):838–54.
49. Liu S, Yang L, Zhang C, Xiang YT, Liu Z, Hu S, Zhang B. Online mental health services in China during the COVID-19 outbreak. *Lancet Psychiatry*. 2020;7(4):e17–8.
50. Twenge JM, King LA. A good life is a personal life: relationship fulfillment and work fulfillment in judgments of life quality. *J Res Pers*. 2005;39(3):336–53.
51. Canha L, Simões C, Owens L, Matos M. The importance of perceived quality-of-life and personal resources in transition from school to adult life. *Procedia Soc Behav Sci*. 2012;69:1881–90.
52. Maass R, Kloeckner CA, Lindstrøm B, Lillefjell M. The impact of neighborhood social capital on life satisfaction and self-rated health: a possible pathway for health promotion? *Health Place*. 2016;2016(42):120–8.
53. Barkhuus L, Dey AK. Location-based services for mobile telephony: a study of users' privacy concerns. *Interact*. 2003;3:702–12.
54. Klasnja P, Consolvo S, Choudhury T, Beckwith R, Hightower J. Exploring privacy concerns about personal sensing. In: *International conference on pervasive computing*. Berlin: Springer; 2009. p. 176–83.
55. Okazaki S, Li H, Hirose M. Consumer privacy concerns and preference for degree of regulatory control. *J Advert*. 2009;38(4):63–77.

56. Gustarini M, Wac K, Dey AK. Anonymous smartphone data collection: factors influencing the users' acceptance in mobile crowdsensing. *Pers Ubiquit Comput.* 2016;20:65–82.
57. Wac K. From quantified self to quality of life. In: *Digital health.* Cham: Springer; 2018. p. 83–108.
58. Wac K. Quality of life technologies (definition). In: Gellman M, Turner J, editors. *Encyclopedia of behavioral medicine.* New York: Springer; 2019.

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